This study, despite being a prospective analysis of consecutive patients, is limited by the fact that it reflects data from a single institution. The generalizability of these findings to other national and international centers will require a prospective multicenter study.

In summary, identification and correction of residual lesions in the operating room is associated with improved outcomes. Enhanced intraoperative imaging, which can provide information on all aspects of a repair, is an important factor in achieving optimal surgical results before exiting the operating room.

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Discussion

Dr Emile Bacha *(New York, NY)*. Meena, a very nice presentation. It is very rare in heart surgery that one can confirm a so-called dogma, so it is nice when you see that happening. Here you are confirming, in a prospective manner no less, that a good or optimal procedure achieved during the first bypass run achieves the best possible results. You also showed that intraoperative recognition and repair of residual defects is superior in terms of outcomes to postoperative recognition and repair. I do not think anybody will argue with your findings, but it is still nice to see them proven scientifically. Your findings were particularly true for premature neonates and young infants and for higher risk categories.

Although your study was focused more on the intraoperative versus postoperative group, that is, the patients who underwent re-repair during the first operation compared with the second operation, I was really interested in the comparison you had between the NO group, no re-repair, versus the intraoperative group,

because you could look at the data differently. You had a higher mortality in the intraoperative re-repair group versus the NO group even though you had the same length of hospital stay, but that may be determined by the patients who died and therefore you had a lower length of hospital stay. I always tended to think about these patients, those who undergo an immediate re-repair, as being equal in terms of prognosis to those who had a first excellent repair.

Could you comment on that, please?

Dr Nathan. I need to mention that the NO group included patients who underwent repair on cardiopulmonary bypass and those who had non–cardiopulmonary bypass procedures such as shunts and unifocalization, and the NO group had a much lower rate of adverse events and mortality because they represented the larger group of patients among the entire cohort. If we compared just the patients who had undergone operations on cardiopulmonary bypass, the difference would probably be much lower, and we are in the process of analyzing that data.

Dr Bacha. So you are saying the groups are not well matched?

Dr Nathan. Not adequately matched, yes.

Dr Bacha. Another surgical dogma is that the enemy of good is better, and that is one of the most difficult things a surgeon has to decide in the operating room. If you have, let's say, a mild or moderate defect but your patient is doing okay, do you go back on bypass and fix it versus do you accept it? That is a very difficult decision to make. Can your data help us decide, maybe from what you know on the technical performance score database, on that particular question?

Dr Nathan. I totally agree with you that the enemy of good is better, and we are actually in the process of developing a score that will help us determine which residual lesions need revision in the operating room versus those that can be followed. Most postoperative revisions were related to valves, and I think this is a group that needs to be studied individually rather than as part of a large cohort. We are in the process of collecting and analyzing data from this group of patients.

Dr Bacha. The third question is regarding the issue of timing of the diagnosis of the residual defect, because I think it makes a difference whether you are reoperating the next day for a major residual defect versus 2 weeks or before discharge, let's say. Do you have any comments on the timing? Was that a factor?

Dr Nathan. The numbers are fairly small, so we could not look at each individual time point of reintervention, but most of the postoperative revisions were more than 48 hours after surgery.

Dr Bacha. Did that make a difference?

Dr Nathan. We have not looked at that specifically because the numbers were too small to do a meaningful analysis.

Dr Bacha. And the last question. The most common type of re-repair was a left AV valve repair. You would expect that, especially if you have a large valve practice. Now, you could argue that if you are doing complex left AV valve repairs, sometimes you simply have to come off bypass, look at your TEE, and then go back on bypass almost in a planned manner. Those were counted as re-repairs.

Do you think you should differentiate between valve re-repairs versus nonvalve re-repairs such as residual aortic arch obstructions, or residual VSDs that may potentially carry a worse prognosis?

Dr Nathan. Thank you very much. I think that is really worth exploring and we will proceed to do so.

Dr Christian Pizarro *(Wilmington, Del)*. Meena, a great presentation and very interesting study. I wonder if you had the opportunity to look at the use of extracorporeal membrane oxygenation (ECMO) in those patients who had residual lesions who were intervened on postoperatively? Not infrequently sometimes there are some of those lesions, the circulation is precarious, and patients are not in good condition. Did you explore about how that use of ECMO early with a plan to go to the operating room, let's say, the next day or so could have affected the outcome?

Dr Nathan. We did look at ECMO, but it was included as a composite in the adverse events, because, again, the numbers in each of the groups were small so that comparison using an individual adverse event was difficult.

Dr Pizarro. And then just briefly, among those patients who had a postoperative intervention, how many of those had a residual lesion that was identified in the operating room but deemed probably not to be important enough? That goes to the judgment at the time, should I leave this, should I act on it?

Dr Nathan. Among the valve repairs, at least on intraoperative assessment, the regurgitation was usually at least a grade or two lower than in later postoperative echocardiograms, so those could not be picked up intraoperatively. Thus several valve repairs that occurred postoperatively had an increase in grade of regurgitation that necessitated their repair.

Dr Mark Danton *(Glasgow, Scotland, UK)*. From your data, obviously it is best to repair any residual lesion at the time of the first operation. So with respect to the residual lesions that required repair at a second or subsequent operation, were those new lesions, first identified in the postoperative phase, or were they lesions recognized at initial surgery but progressed over time, or finally was the gravity of lesion underappreciated at the time of intraoperative assessment. If it were the case that the significance of the residual lesion was underestimated at surgery, is there a better way of identifying them and their significance at the first operation so that you do not have to deal with them at a subsequent operation?

Dr Nathan. A small percentage of the valve re-repairs postoperatively were related to an increase in regurgitation grade related to either a torn stitch or new additional regurgitation that was not identified in the operating room. So I think intraoperative assessment should not only include a good echo, it should also include clinical assessment, which is what all of us do in the operating room. And we are in the process of trying to define the intraoperative echo findings that match the postoperative echo findings that will identify which intraoperative echo findings require a revision. We are currently in the process of comparing intraoperative echos to postoperative echos to arrive at cut points that will define better when we should intervene in the operating room compared with postoperatively.

Dr Matthias Siepe *(Freiburg, Germany)*. Excellent study. Thank you. I am a little bit confused about those patients who required a catheter-based intervention. In which group did you put those patients? Or should there be a fifth group with catheter-based reinterventions?

Dr Nathan. Currently these patients are included in the postoperative revisions, because some of the patients did require postoperative pulmonary artery stenting or dilation. The numbers are fairly small, but we will try and analyze that group as a separate group and see if there is a difference.